

## History and Geomorphology of Fletcher Slough and Lower Joe Culvert Creek, 1906 through 2002

Fletcher Slough, a side channel in the Quinault River system, is located on the south side of the Quinault River valley between RK 13.8 and RK 14.4 (Figure 1). It is opposite from a bedrock knob on the north side of the valley. Joe Culvert Creek is a tributary that enters the Quinault River near RK 14.5 on the north side of the valley (Figure 1). North Slough is on the north side of the valley just downstream from Joe Culvert Creek, and Bunchfield Slough is just upstream of Joe Culvert Creek between RK 15.7 and 17 (Figure 1).

Lower Joe Culvert Creek is a habitat area that includes the downstream about 200 m of the Joe Culvert Creek tributary channel and about 200 m of an old Quinault River channel, where the tributary enters the Quinault River system. Joe Culvert Creek tributary flows along a remnant of a Pleistocene surface that is preserved along the east side of the bedrock knob north of the Quinault River (Figure 1). Lower Joe Culvert Creek habitat area crosses the HCMZ boundary. The upstream half of the habitat area is outside of the HCMZ; the downstream half is within the HCMZ and has been affected by channel processes related to the Quinault River.

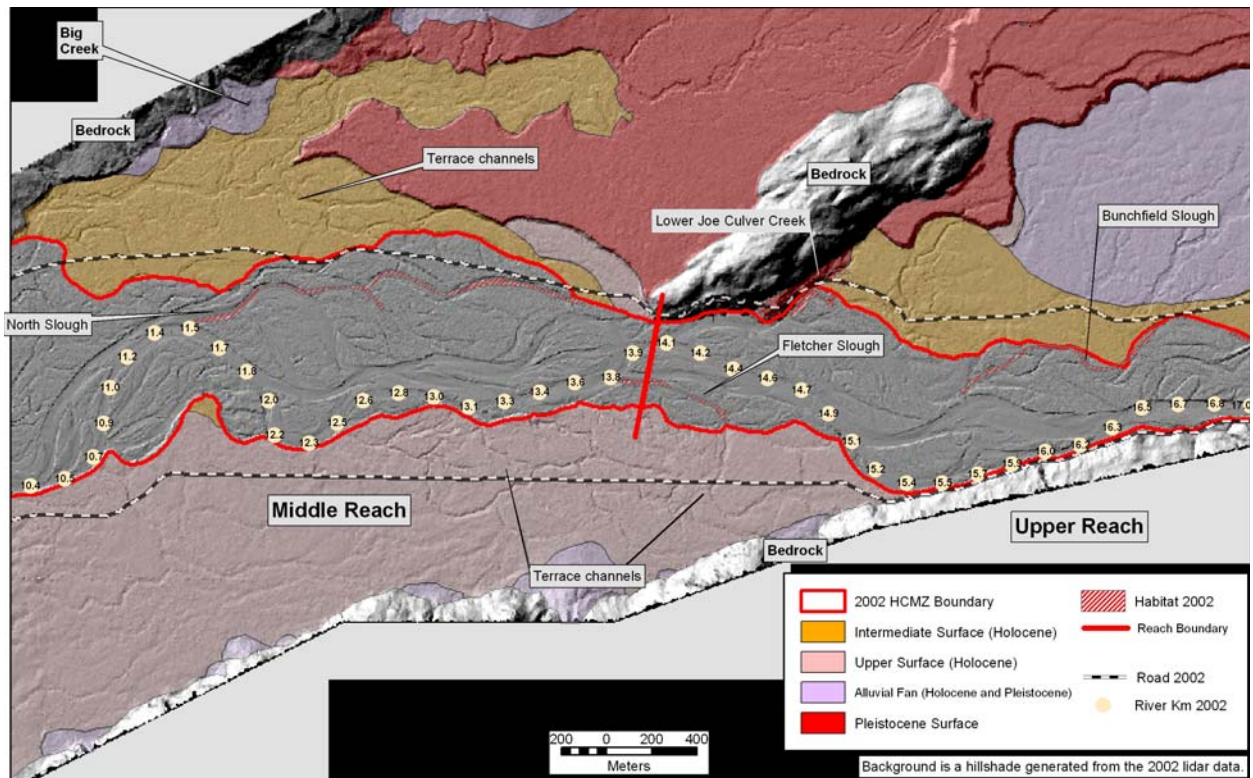


Figure 1. Fletcher Slough is located between RK 13.8 and RK 14.4 along the south side of the historical channel migration zone (HCMZ). Lower Joe Culvert Creek habitat includes the downstream part of a tributary that enters the Quinault River near RK 14.5 and the part of an old Quinault River channel where the tributary enters the Quinault

River system. Consequently, Lower Joe Culvert Creek habitat is both within and outside of the CMZ. River kilometers are from the low-flow channel at the time of a river survey in 2002.

### **Terrace Channels on the Upper Surface South of the Quinault River**

Terrace channels are present on the Upper Surface south of the Quinault River from upstream of Fletcher Slough (near RK 15.4) and to downstream of North Slough (near RK 10.5) (Figure 1). The terrace channels form a complex network, which is connected to the Quinault River at both upstream and downstream ends. However, not all of the channels are connected directly to the Quinault River. The terrace channels are deeply dissected (up to about 5 m) to about the elevation of the present main Quinault River channel (Figure 2). Alternating gravelly alluvium (channel deposits) and fine-grained silt and sand beds (floodplain deposits) are exposed in the banks of the terrace channels (Figure 2). Wood is common in the terrace channels. Root wads have created scour pools in the channel beds. Large single logs or jams form hydraulic controls. At times of low flow in the Quinault River, water is still present in the scour pools. Flow in the terrace channels is fed from both the surface connections to the river and groundwater. The Upper Surface adjacent to the terrace channels has vegetation of various ages, including areas of mature forest. The terrace channels provide sockeye habitat as indicated by observed redds (B. Armstrong, QIN, 2004, oral commun.). Some of the terrace channels have been impacted by human activities. For example, a bridge with a culvert is present across a terrace channel near Fletcher Creek.



Figure 2. Bank exposure along one of the terrace channels on the south side of the Quinault River between RK 10.5 and RK 15.4. Note the depth of the incision and the alternating gravelly channel deposits and fine-grained floodplain deposits exposed in the bank. Photograph taken by J.Bountry (Bureau of Reclamation, Denver, 2004).



## Changes in Fletcher Slough and Lower Joe Culvert Creek by Year

The following maps (Figures 3 through 12) show the history of formation and destruction of potential habitat in the area of Fletcher Slough and the downstream part of Lower Joe Culvert Creek between 1906 and 2002. Figure 13 shows the relationship between erosion of the HCMZ boundary and habitat formation and destruction for this time interval. Figure 14 shows the upstream part of Lower Joe Culvert Creek and discusses possible changes in habitat characteristics during the last few years.

### 1939 and Earlier

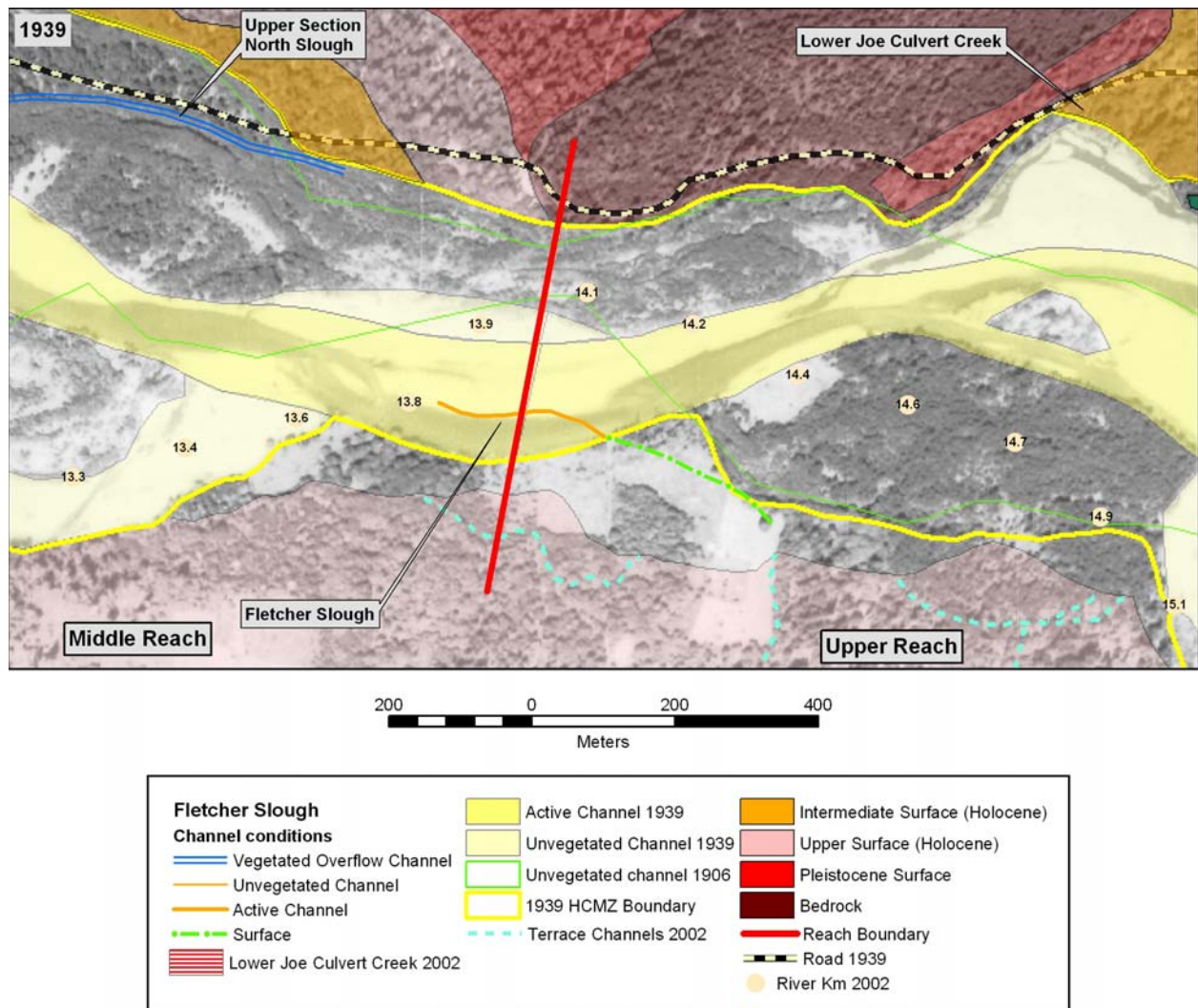


Figure 3. The area between RK 13.3 and RK 15.0 as it looked in 1939. The 1906 (green outline) unvegetated channel was north of Fletcher Slough, which did not appear to have been present in these years. In 1906 and 1929, the area of the slough was part of the bank that included buildings, which indicates that the area was likely outside of the historical channel migration zone.

By 1939, the downstream about 250 m of Fletcher Slough had been excavated and was part of the active channel of the Quinault River. The upstream half of Fletcher Slough had not yet been excavated and was still part of a surface outside of the historical channel migration zone. The surface in the area of the future Fletcher Slough had been cleared of vegetation by 1939. The presence of buildings on this surface in 1906 and 1929 suggests that the surface was cleared much earlier.

The downstream part of Lower Joe Culvert Creek (within the HCMZ) was part of the unvegetated channel in 1939, so the future habitat channel had already been excavated by that time. The active channel between about RK 14.5 and RK 15.0 was near the center of the 1939 CMZ. The downstream part of Lower Joe Culvert Creek did not appear to be part of the unvegetated channel in 1906, but may have been part of the unvegetated channel of the Quinault River by 1929.

1952

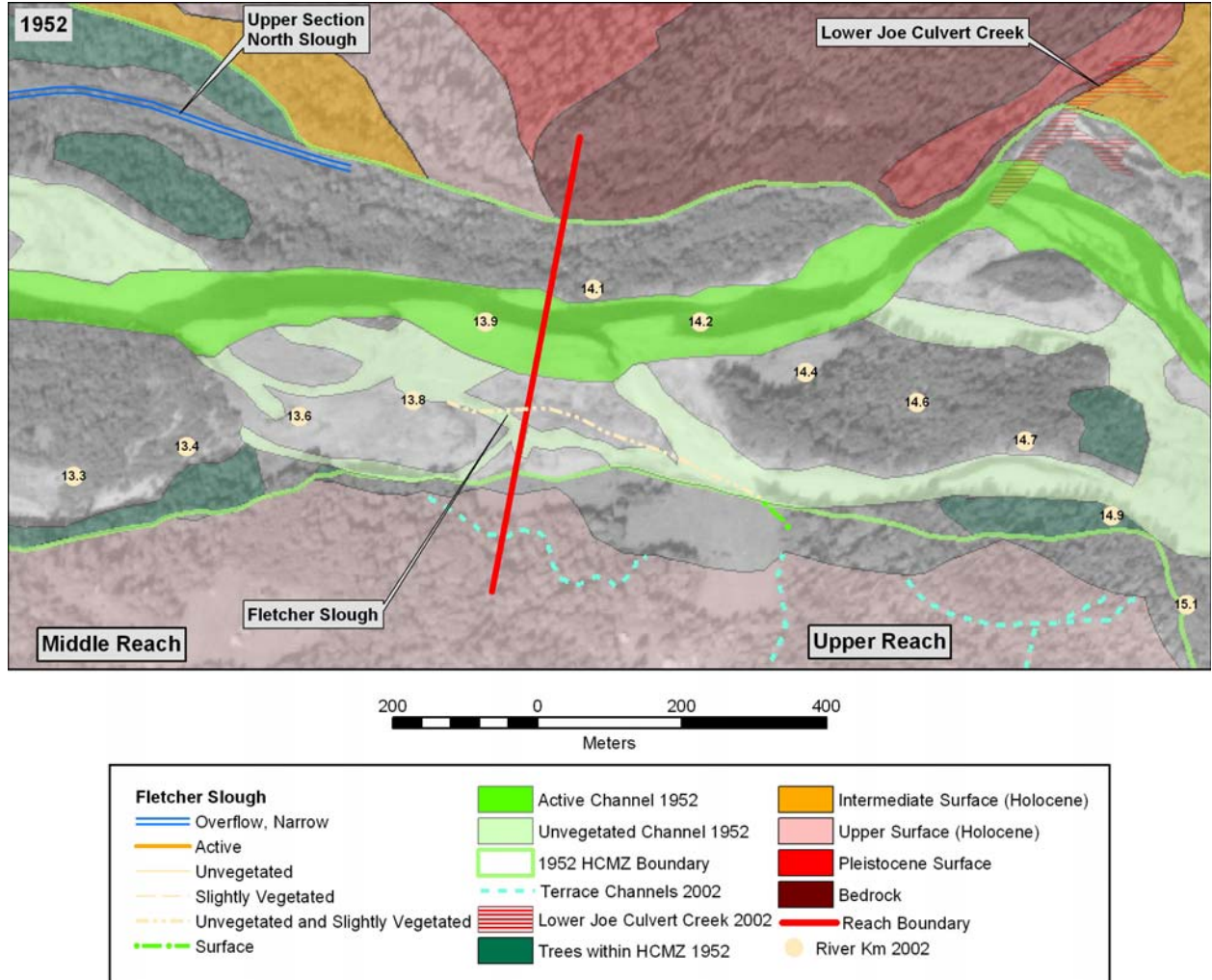


Figure 4. By 1952, most of Fletcher Slough had been excavated by the Quinault River. Only about 50 m at the upstream end did not yet exist and was in an area of the still-cleared surface. Most of Fletcher Slough was in either an unvegetated channel or a slightly vegetated channel of the Quinault River. No potential habitat appeared to exist in 1952.

In 1952, the downstream about 100 m of the downstream part of Lower Joe Culvert Creek was part of the active channel of the Quinault River, because the active channel between RK 14.5 and RK 15.0 had meandered to the north between 1939 and 1952. The upstream about 100 km of the downstream part of Lower Joe Culvert Creek is a sparsely vegetated channel of the Quinault River. This channel was part of the unvegetated channel in 1939, but appears to carry little flow by 1952.

The active and unvegetated channels of the Quinault River between about RK 14.5 and at least RK 15.0 had three paths in 1939. These paths are separated by vegetated islands.



1958

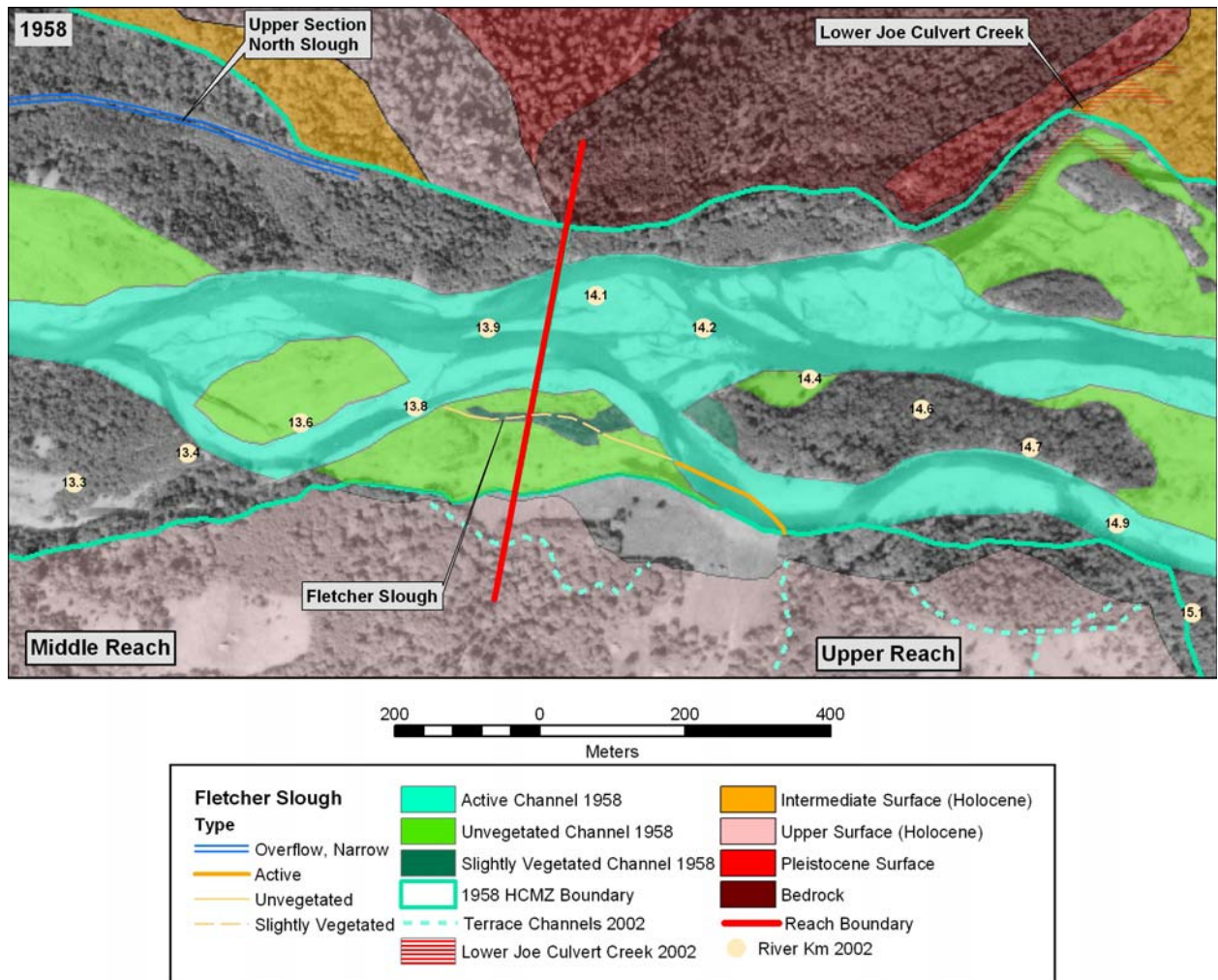


Figure 5. By 1958, the CMZ boundary had expanded or eroded to include all of Fletcher Slough. The upstream about 250 m was part of the active channel of the Quinault River. The downstream half of Fletcher Slough was either within an unvegetated channel or a slightly vegetated channel of the Quinault River.

By 1958, the entire downstream part of Lower Joe Culvert Creek was part of the unvegetated channel of the Quinault River, as it was in 1939. The active channel of the Quinault River in 1958 occupied the middle and left paths of the three channel paths that were present in 1952.

1962

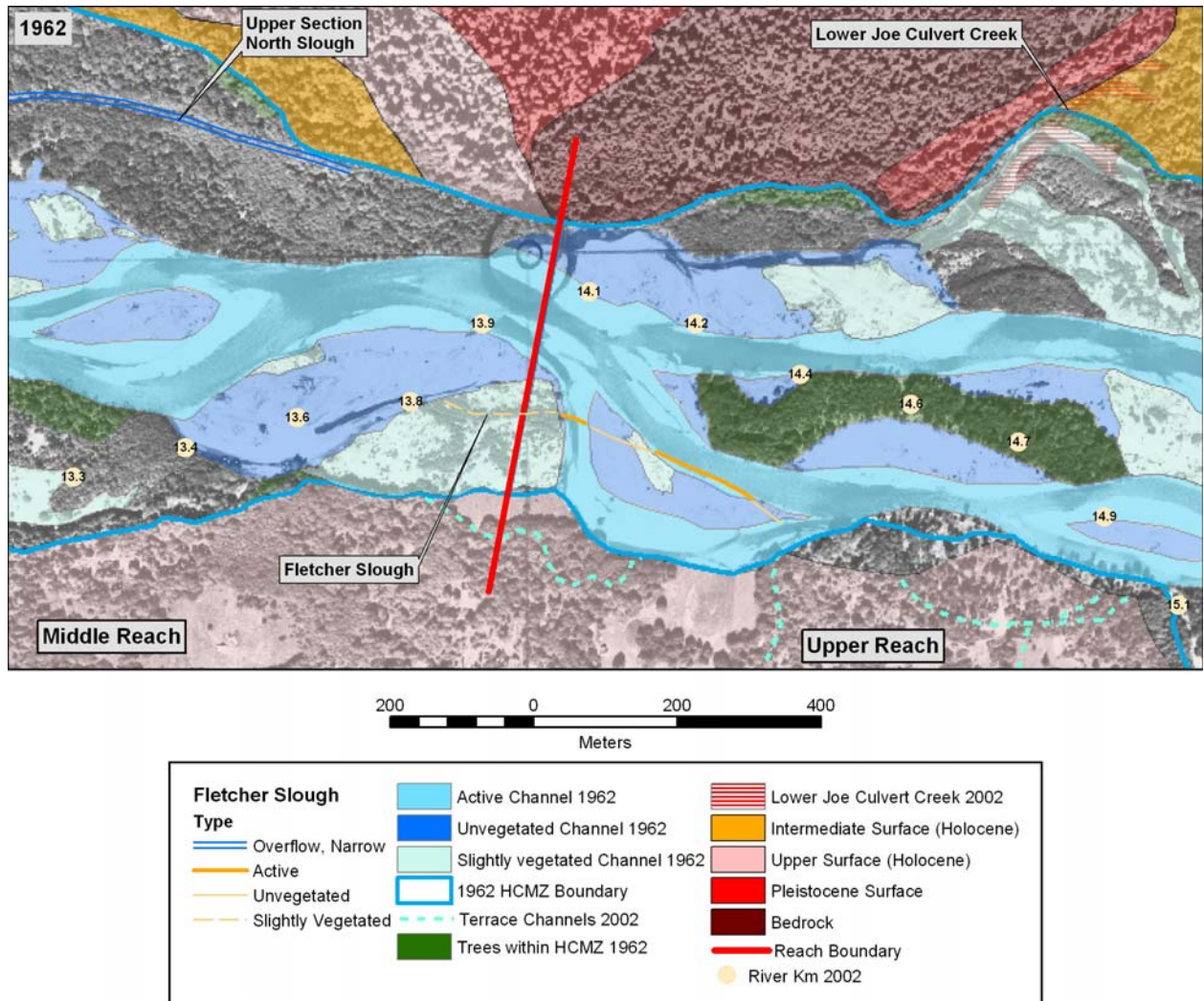


Figure 6. By 1962, the downstream about 150 m of Fletcher Slough was across a slightly vegetated channel of the Quinault River. A small channel appeared to have coincided with this section of the slough and may have provided initial conditions for habitat. The rest of Fletcher Slough was part of either the active channel or unvegetated channel of the Quinault River and did not appear to be potential habitat because of the high flows in these channels.

By 1962, the downstream part of Lower Joe Culvert Creek was part of a sparsely vegetated channel of the Quinault River, suggesting that this channel has less or less frequent flows than it did in 1958. The right (north) path of the active channel of the Quinault River was straighter and closer to the center of the CMZ than it was in 1958 (and, consequently, farther away from the downstream part of Lower Joe Culvert Creek).



1973

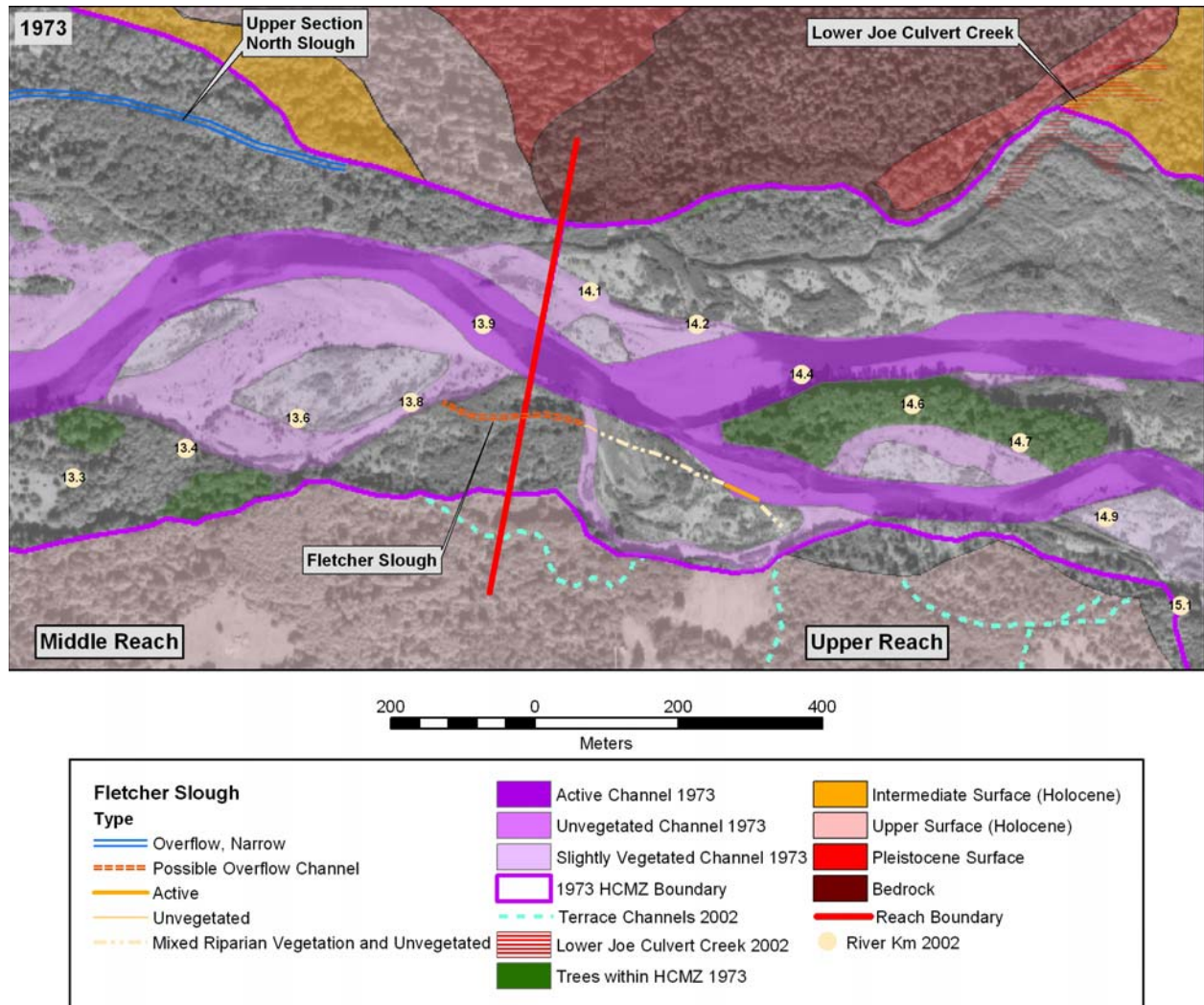


Figure 7. By 1973, the downstream about 150 m of Fletcher Slough flowed across a surface that had thicker and larger riparian vegetation than it did in 1962. This section of the slough may have been potential habitat. Most of the upstream section was across a surface with only scattered vegetation. The exceptions were two short sections: one near the upstream end that was within the active channel of the Quinault River and one near the middle of the slough that was crossed by an unvegetated channel of the Quinault River. By 1973, the downstream part of Lower Joe Culvert Creek appeared as a narrow channel through a vegetated surface. This channel does not appear to have had a direct upstream connection to the Quinault River. The creek appears to have continued downstream of its mapped extent in 2002 as a narrow channel that joined the Quinault River near RK 14.0. The narrow channel may have been connected to the Quinault River at higher flows, because a partially vegetated area was present between the two channels. The entire narrow channel had a length of about 700 m. The narrow channel downstream of the downstream part of Lower Joe Culvert Creek section was part of the unvegetated channel in 1962, and so was excavated by that time.



1982

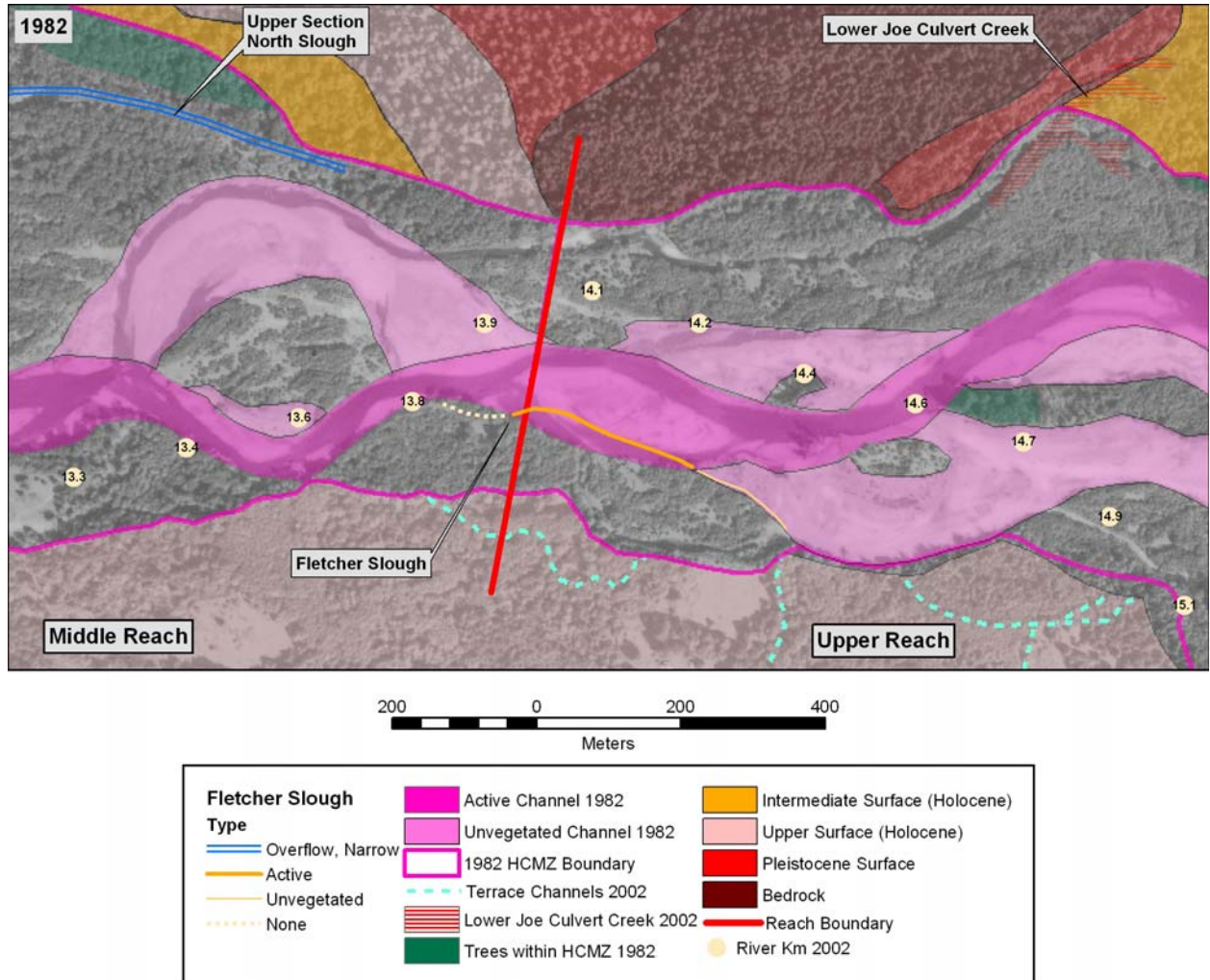


Figure 8. By 1982, the downstream section that was possible habitat at Fletcher Slough in 1973 had shortened to a little more than 100 m. The rest of the Fletcher Slough was part of the active channel or the unvegetated channel of the Quinault River and did not appear to provide potential habitat.

The configuration of the downstream part of Lower Joe Culvert Creek was nearly the same in 1982 as it was in 1973. The narrow channel that extends downstream of the 2002 extent of Lower Joe Culvert Creek has extended downstream about 100 m, for a total length of about 800 m. The partially vegetated area between the narrow channel and the Quinault River has become mostly filled with vegetation since 1973.

By 1982, the active channel of the Quinault River had moved to the south between RK 14.5 and RK 15.0, and had eroded part of the vegetated island that had formed between the central and south paths before 1952. The smaller island to the north, closer to Lower Joe Culvert Creek, has become part of the vegetated area within the HCMZ.

1994

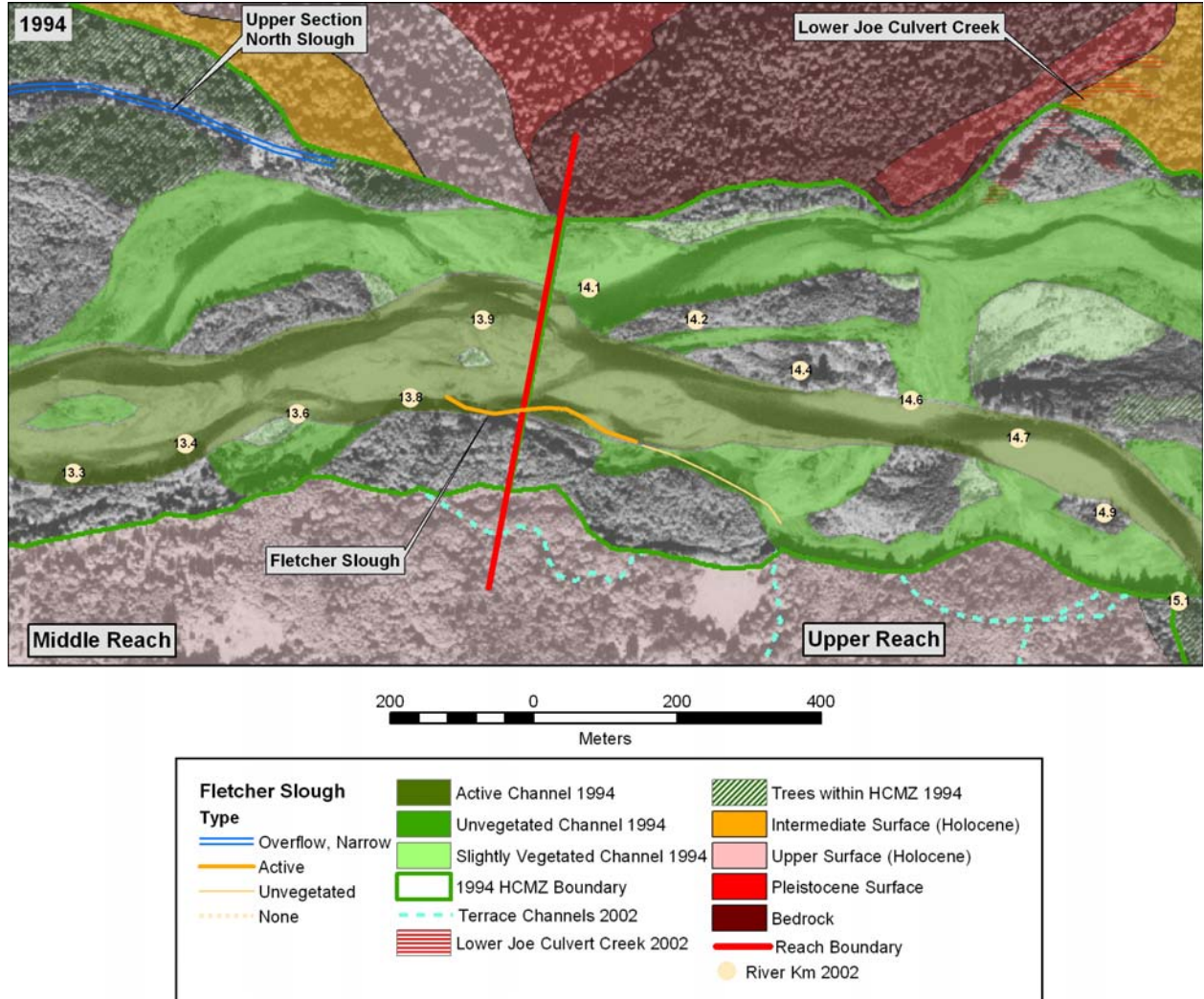


Figure 9. By 1994, the entire Fletcher Slough was within either the active channel or the unvegetated channel of the Quinault River. No potential habitat appears to be present at this time.

By 1994, the unvegetated channel of the Quinault River between about RK 14.5 and RK 15.0 has split flow. The north path extended into the downstream about 35 m of the downstream part of Lower Joe Culvert Creek. Upstream of this 35-m-long section, the downstream part of Lower Joe Culvert Creek was still a narrow channel through a vegetated surface. This part of Lower Joe Culvert Creek in 1994 was a secondary or side channel that was connected to the Quinault River at both its upstream and downstream ends.



1998

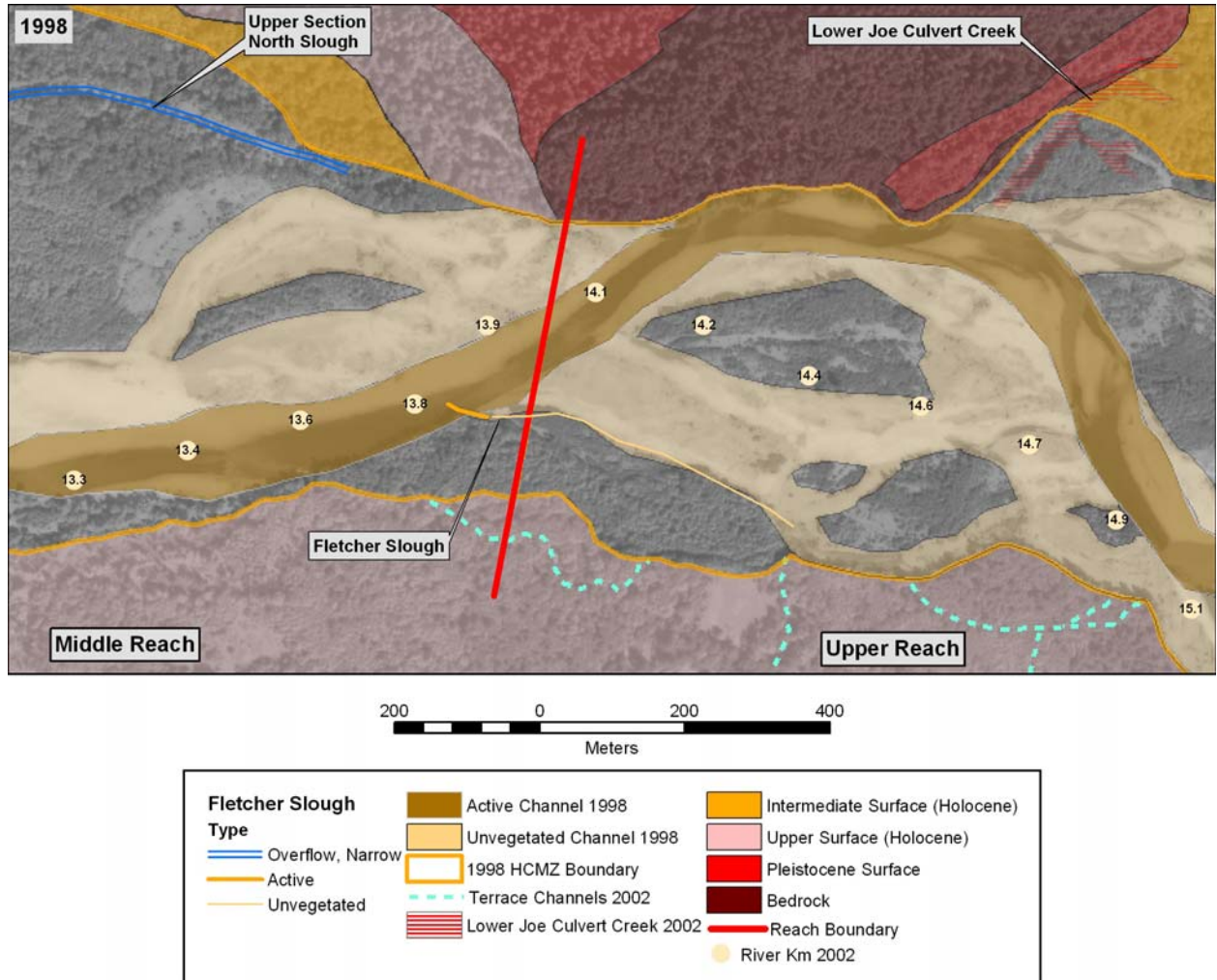


Figure 10. The section of active channel that coincided with Fletcher Slough in 1994 was mostly unvegetated channel by 1998. However, the entire length of the slough was still within either the unvegetated channel or active channel of the Quinault River. Consequently, no potential habitat appeared to be present at this time.

By 1998, the active channel of the Quinault River had meandered to the north in the area of the downstream part of Lower Joe Culvert Creek. This part of Lower Joe Culvert Creek was a narrow channel through a vegetated surface. The channel may have been slightly wider than it was in 1994. This part of Lower Joe Culvert Creek in 1998 was a secondary or side channel that was connected to the Quinault River at both its upstream and downstream ends.



2001

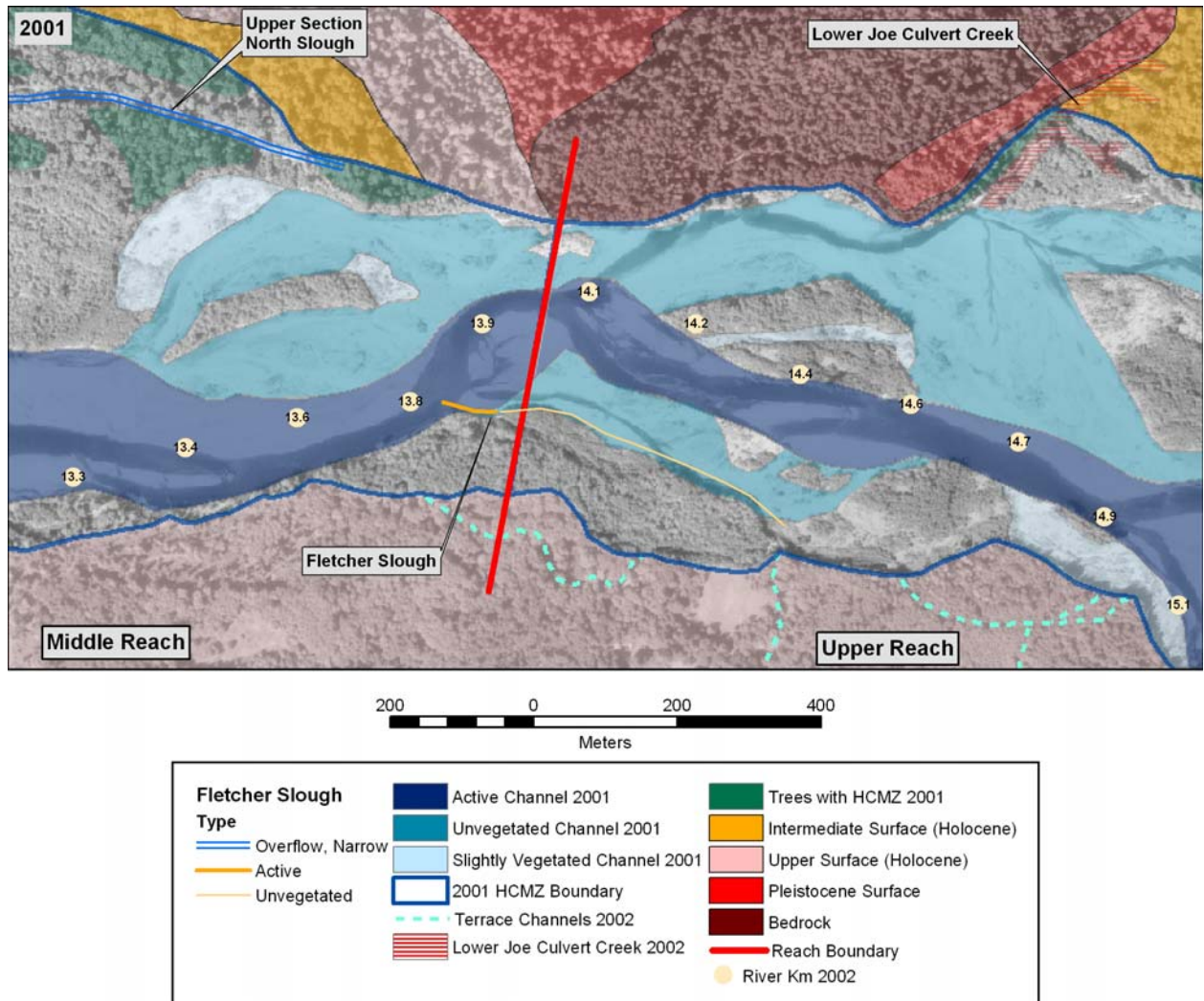


Figure 11. Although the unvegetated channel that coincided with Fletcher Slough appeared to have less flow in 2001 than it did in 1998, the slough was still within either the active or unvegetated channel in 2001. No potential habitat appeared to be present.

In 2001, the downstream part of Lower Joe Culvert Creek remained a narrow channel through a vegetated area. The active channel of the Quinault River had moved to the south, and was no longer at the downstream end of the creek. The downstream part of Lower Joe Culvert Creek in 2001 was a secondary or side channel of the Quinault River and was connected to the river at both its upstream and downstream ends.

2002

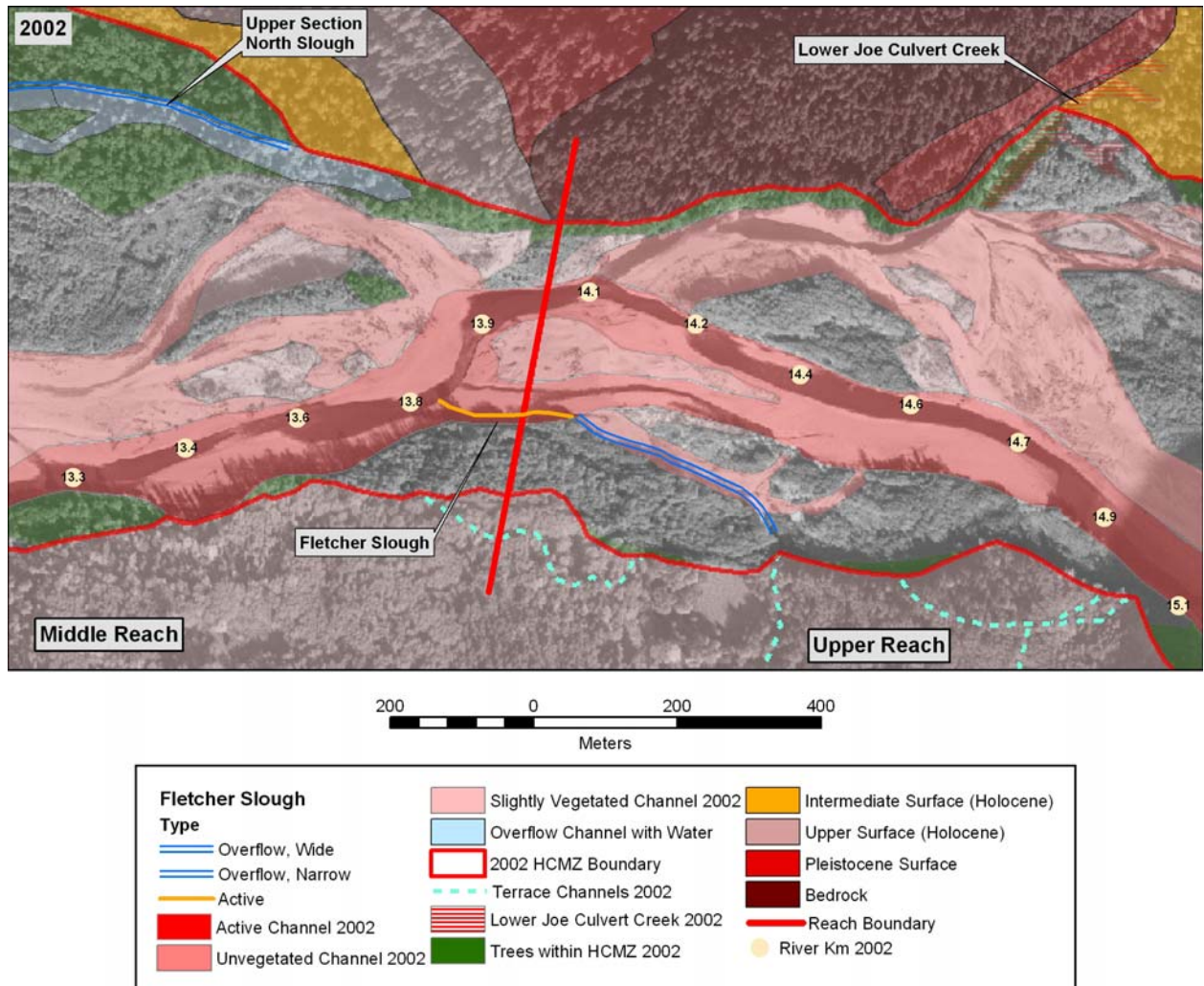


Figure 12. By 2002, the upstream about 500 m of Fletcher Slough appeared to be within a relatively wide overflow channel through riparian vegetation. (The active channel had abandoned this path.) This section of the slough appeared to be potential habitat. Water is visible in the channel in 2002. The downstream about 100 m of Fletcher Slough was still part of the active channel of the Quinault River in 2002, and did not appear to have been potential habitat.

The downstream part of Lower Joe Culvert Creek in 2002 had a configuration similar to its configuration in 2001. This part of Lower Joe Culvert Creek in 2002 was a secondary or side channel of the Quinault River and was connected to the river at both its upstream and downstream ends.



## Erosion by Year

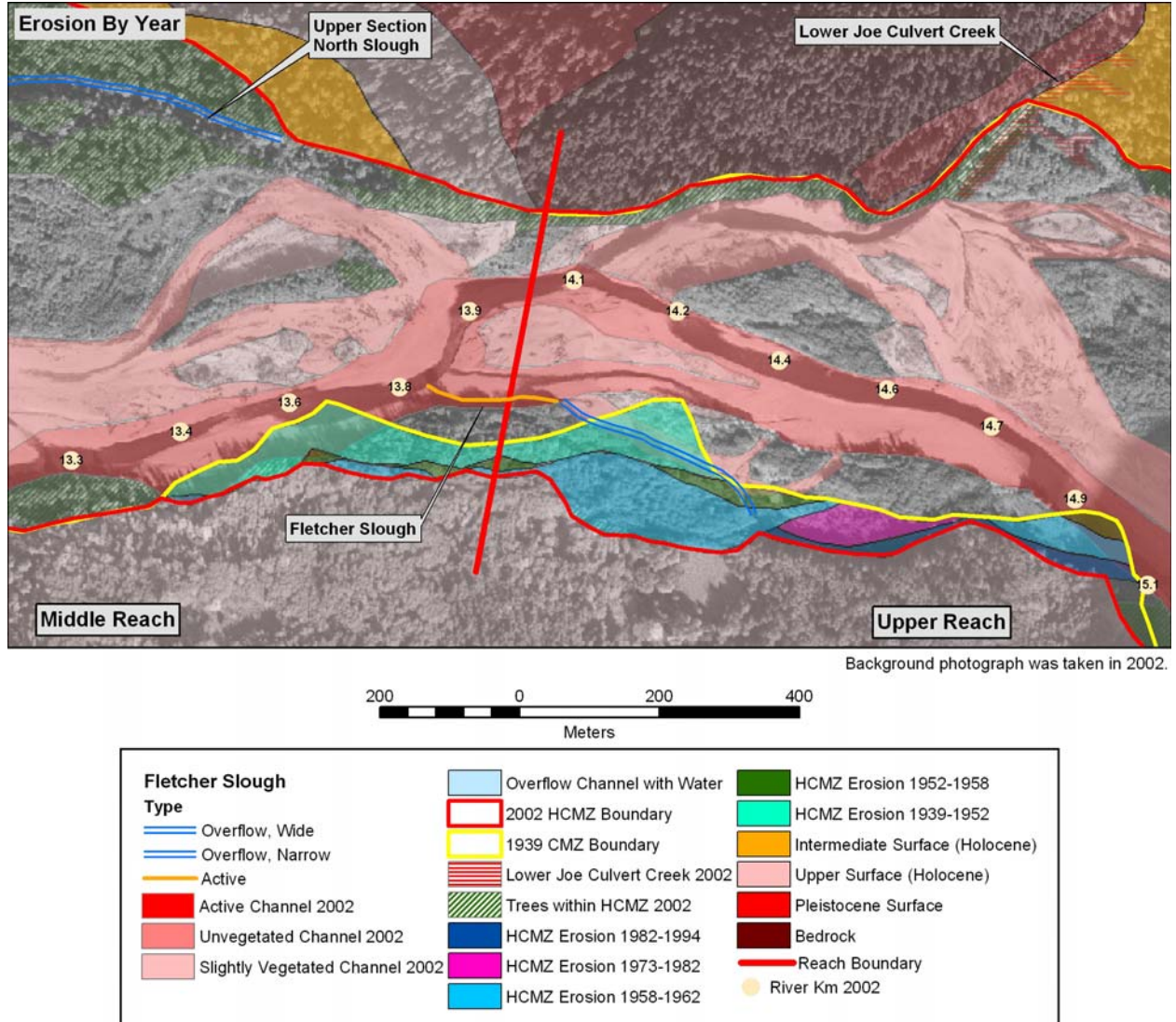


Figure 13. Erosion of the left (south) boundary of the HMCZ between 1939 and 1962 allowed the upstream about 500 m of Fletcher Slough to form. Most of this erosion occurred between 1939 and 1952. Erosion of the bank immediately upstream of Fletcher Slough continued between 1973 and 1994. The downstream about 200 m of Fletcher Slough has been part of the historical channel migration zone since some time between 1929 and 1939.

The right or north boundary of the HCMZ along this section of the valley has not eroded since 1939. This may be because of the bedrock that composes about half of the boundary in this section. Thus, erosion of the HCMZ boundary has not been a factor in the configuration of and changes in Lower Joe Culvert Creek between 1939 and 2002.



## Changes in the Upstream Part of Lower Joe Culvert Creek (outside of the HCMZ)

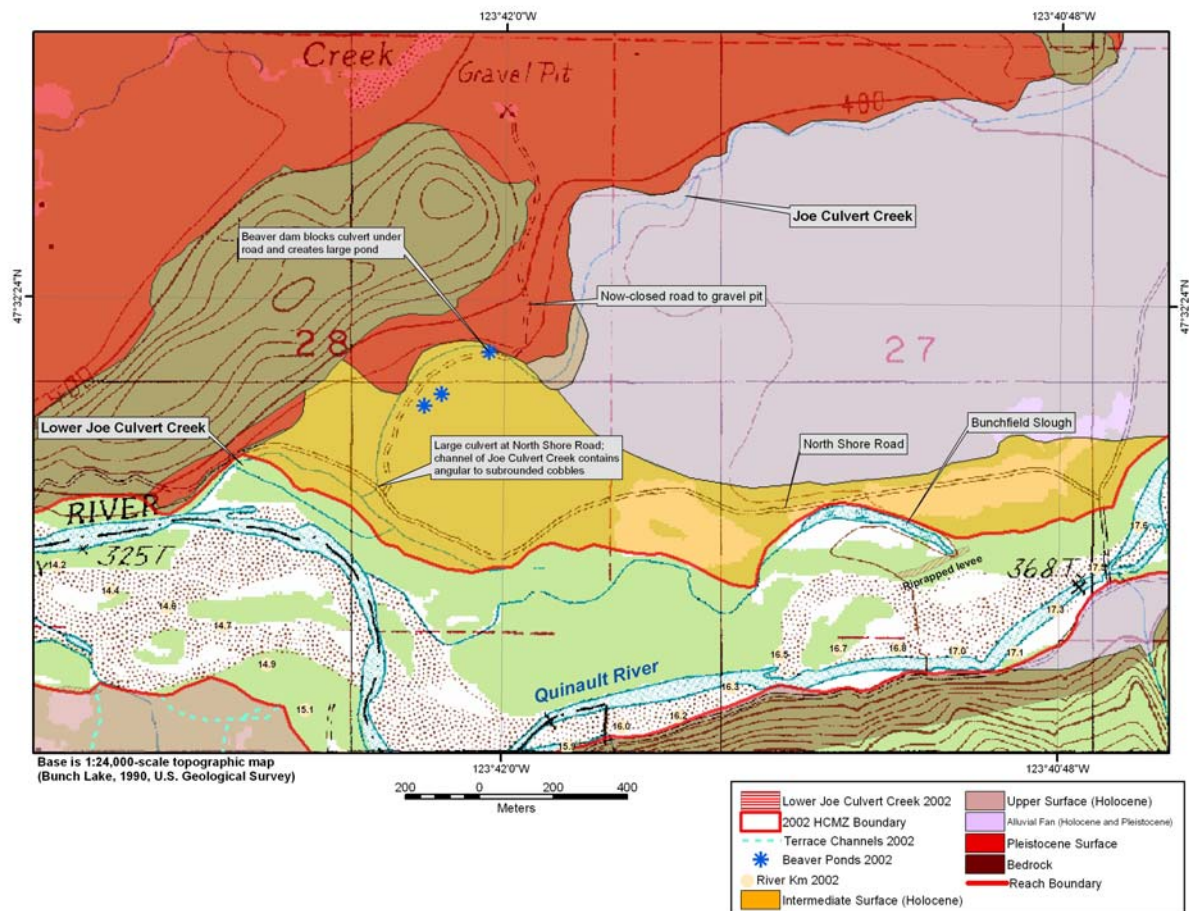


Figure 14. The upstream part of Lower Joe Culvert Creek (outside of the HCMZ) is the downstream end of a tributary that heads along a bedrock ridge north of section 27. Because this part of Lower Joe Culvert Creek is outside of the HCMZ, it has not been affected by processes in the Quinault River channel. The approximate location of beaver dams in 2002 are shown by the blue stars. One dam blocks a road culvert, which creates a large pond. Before the culvert was blocked and the pond formed, sockeye and coho probably had access to spawning areas upstream to the upper end of the bedrock knob.

An old dirt road, which led to a gravel quarry, crosses the creek. Beaver activity also has affected the channel during the last about 10 years. The approximate location of beaver dams in 2002 are shown by the blue stars. One dam blocks a road culvert, which creates a large pond. Before the pond was present, spawning took place in the creek upstream to the upper end of the bedrock knob. Until the middle 1990s, sockeye used the tributary channel up to the culvert-blocking beaver dam. The dam caused headward channel cutting along the road, which started during the winter of 2000-2001 and accelerated during the winter of 2001-2002. The incision has improved the sockeye's access to the beaver pond. The pond may have increased the amount of rearing habitat in the tributary. Additional changes in habitat are likely because of the interaction of the beaver activity, the old road, and channel incision.